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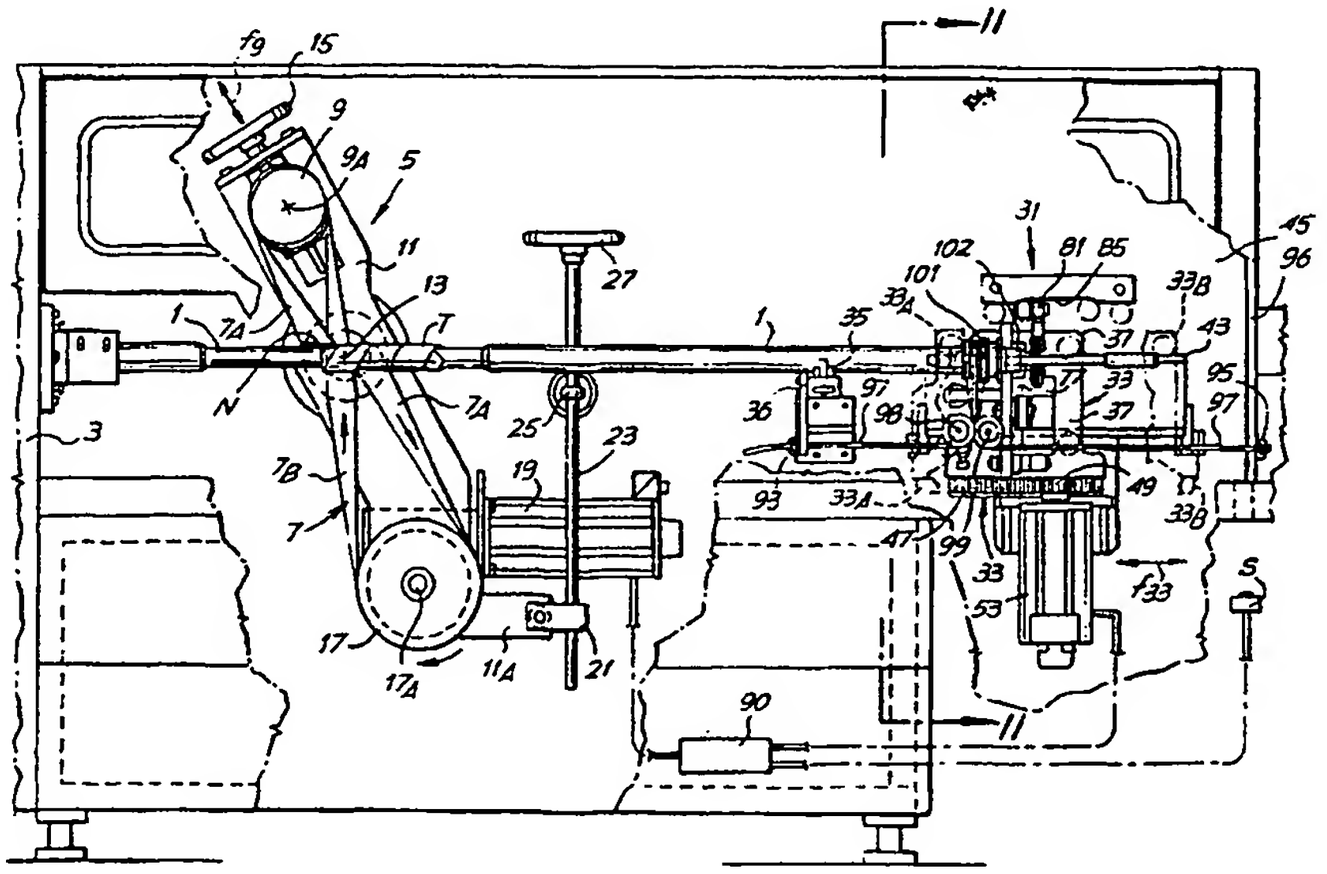
(54) Title: MACHINE FOR PRODUCING TUBES CONTINUOUSLY, WITH INDEPENDENT OPERATION OF THE CUTTING UNIT



(57) Abstract

A machine for producing tubes by winding into a spiral a ribbon-shaped material (N) on a spindle (1), comprises a winding unit (5) which continuously winds into a spiral two or more overlapping and staggered strips of ribbon-shaped material (N) on the said spindle (1) and causes the tube (T) formed from the said material to advance continuously, and a cutting unit (33) fitted with tube (T)-cutting means (63, 65) and provided with a reciprocating motion along the direction of advance of the tube, to cut the said tube into sections of predetermined length during the advance of the tube. The winding unit (5) is driven by a first actuator (19), and the reciprocating motion of the cutting unit (33) is provided by a second actuator (53); the actuators are electronically controlled (90) in such a way that the speed of advance of the cutting unit (33) during the cutting is substantially equal to the speed of advance of the tube produced by the said winding unit (5).

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Description

Machine for Producing Tubes Continuously, with Independent Operation of the Cutting Unit

Technical Field

The invention relates to a machine for producing tubes by winding into a spiral two or more overlapping and staggered strips of a ribbon-shaped material on a spindle, comprising a winding unit which continuously winds into a spiral the strips of ribbon-shaped material on a spindle and causes the tube formed from the said material to advance continuously, and a cutting unit fitted with tube-cutting means and provided with a reciprocating motion along the direction of advance of the tube, to cut the said tube into sections of predetermined length during the advance of the tube.

These machines are normally used in the paper processing industry to produce tubes or what are known as tubular cores of cardboard or similar, on which a layer of paper is subsequently wound to produce rolls. Similar applications are found in other sectors where it is necessary to wind a ribbon-shaped material on a tubular core to produce rolls, for example in the production of plastic film for industrial or domestic use, materials based on metallized film for packaging, and the like. Similar tubes are also used to produce containers for solid or liquid products, particularly in the food industry.

Background Art

In these machines, a system with crank links is normally provided to transmit the motion from the winding unit to the cutting unit, which has to move with a reciprocating motion to make the cut while advancing in the direction of feeding of the tube and then return to the starting position. These machines have the disadvantage that the motion of the cutting unit and

consequently of the cutters never takes place at a speed equal to the speed of feeding of the tube being formed, so that there is always a relative displacement between the cutters and the tube even in the cutting phase.

To avoid these problems, a system described in Italian Patent No. 1,204,029 was designed, in which the cutting unit and the cutters are driven in their active travel directly by the tube on which the cutters are to act. The return travel is provided by return springs. This system has certain limits of speed and output due to the fact that the driving force exerted by the tube through the cutters on the cutting unit is limited.

The object of the present invention is to provide a machine of the type described initially which does not have the problems of the known machines mentioned above.

Disclosure of the Invention

Essentially, the machine according to the present invention is characterized in that the said winding unit is driven by a first actuator, the reciprocating motion of the cutting unit is provided by a second actuator, and the said actuators are electronically controlled in such a way that the speed of advance of the cutting unit during the cutting is substantially equal to the speed of advance of the tube produced by the said winding unit.

With this disposition, it is possible to control the cutting unit in such a way that it moves, for each cutting operation, in the direction of advance of the tube, through a first section of travel from zero speed to the speed of advance of the tube, a second section of travel at a speed substantially equal to the speed of advance of the tube, and a third section of travel at a speed decreasing from the speed of advance of the tube to zero, before moving through a return travel in the opposite direction. In this way, since the cut is made to take place during the second

section of travel, there is no relative displacement in the direction of advance between the tube and the cutting members, and a virtually perfect cut of the tube is obtained.

Advantageously, to reduce the inertial forces present, the actuator driving the cutting unit will be disposed so that it is fixed with respect to the structure of the machine and will transmit the motion to the cutting unit through a suitable kinematic mechanism. The said kinematic mechanism may comprise, for example, a flexible member run around a pulley caused to rotate by the actuator of the cutting unit. To ensure the maximum synchronization and to reduce the inertial forces, however, it is preferable to use a rack and pinion mechanism.

Further advantageous characteristics of the machine according to the invention are indicated in the attached dependent claims.

Brief Description of the Drawings

The invention will be more readily understood from the description and the attached drawing, which shows a non-restrictive practical embodiment of the invention. In the drawing,

Fig. 1 is a side view of the machine;

Fig. 2 is a section through II-II in Fig. 1;

Fig. 3 is an enlarged side view, with parts removed, of the cutting unit through III-III in Fig. 4; and

Fig. 4 is a rear view through IV-IV in Fig. 3 and a partial section.

Best Mode for Carrying out the Invention

With reference initially to Figs. 1 and 2, the machine comprises a winding spindle or mandrel 1, fitted to and projecting from the column 3 of the machine. The spindle 1 may be fixed or fitted free-running so that it can rotate during the production of the tube. The number 5 indicates in a general way the winding unit which winds the ribbon-shaped material

into a spiral on the spindle 1 to form the tube. This tube, during the continuous formation, is constantly rotated and advanced along its own axis and consequently along the spindle 1. The ribbon-shaped material, in the form of at least two staggered strips, is fed in a direction substantially perpendicular to the plane of Fig. 1, and in the said figure the transverse section N of the material may be seen.

The winding unit comprises a belt 7 running around a roller 9 with an axis 9A slightly inclined with respect to the horizontal. The roller 9 is carried by a moving element 11 hinged, about an axis 13, to the structure of the machine. The position of the roller 9 may be adjusted in the direction F9 by a handwheel 15 to adjust the tension of the belt 7. The belt takes its motion from a pulley 17 with a substantially horizontal axis 17A, rotated by an actuator 19 in the form of a brushless or other motor. The motor 19 is carried directly by the moving element 11. This element has in its lower part an appendage 11A integral with a threaded bush 21, in which is engaged a threaded bar 23 supported at 25 by the structure of the machine and fitted with a handwheel 27. By means of the handwheel 27 and the threaded bar 23 it is possible to adjust the inclination of the moving element 11 about its own axis 13, in order to vary the angle of winding of the ribbon-shaped material N on the spindle 1. The number 7B indicates the ascending section of the belt 7.

The belt 7 has a first section 7A which is wound with one turn around the spindle 1. The inclination of the turn formed by the section 7A depends on the inclination of the moving element 11. The ribbon-shaped material N is inserted between the spindle 1 and the section 7A of the belt at the point of the turn which the belt forms around the spindle, so that the rotation of the pulley 17 and the pull of the belt 7 cause the traction and winding of the ribbon-shaped material on the spindle.

A second strip of material, with its lower

surface provided with glue, is wound on the first, and staggered by approximately half its width.

In this way the tube is formed and advances along the spindle as it is formed. It is possible to have formation with more than two strips in the same way, other strips being laid down each with its lower surface provided with glue.

The spindle 1 extends to a cutting station 31 which comprises a cutting unit 33 movable with reciprocating motion as shown by the double arrow f33. In an intermediate position, the spindle 1 is supported by rollers 35 fitted on an assembly 36 and forming a subdividing member for the support of the spindle 1.

The cutting unit 33 is illustrated in detail in Figs. 3 and 4. It has a carriage 37 free to run on guide rollers 39, 41 with a V-shaped groove, on a double guide 43 integral with the structure 45 of the machine. The carriage 37 is integral with a rack 47 engaging with a pinion 49 keyed to the output shaft 51 of an actuator 53. This actuator consists, in the example illustrated, of an electric motor of the brushless type, but may also be a geared motor.

The actuator 53, supported by the fixed structure 45 of the machine, can rotate in one direction and in the other to impart the reciprocating motion to the cutting unit 33 for the purposes described below.

On the cutting unit 33 there are pivoted at 57 and 58 two oscillating arms 59 and 61 respectively, which each carry at their ends cutting means in the form of rotating circular cutters 63 and 65. The numbers 67 and 69 indicate two guards of the rotating cutters, pierced at 67A and 69A respectively, for the insertion of a lubricating felt.

The oscillating arms 59 and 61 are connected together by a link or rod 71 hinged at 73 and 75 to the arms 59 and 61 respectively. In this way the arms 59 and 61 are kinematically interconnected so that they are made to oscillate simultaneously by a single

cylinder and piston actuator 77, whose cylinder is connected at 79 to the carriage 37, while the rod 80 is hinged at 81 to an extension 59A of the oscillating arm 59.

The extension 59A of the oscillating arm 59 is associated with a follower 83 interacting with a cam profile 85 integral with the structure 45 of the machine. The cam profile 85 has a first rectilinear portion 85A, parallel to the direction of advance of the tube T and therefore to the axis of the spindle 1; a second ramp portion 85B which connects the portion 85A to a third rectilinear portion 85C parallel to the portion 85A; and a fourth ramp portion 85D which connects the portion 85D to a final rectilinear portion 85E parallel to the portions 85A and 85C. The portions 85A and 85E are substantially in the same plane.

The operation of the cutting unit described up to this point is as follows.

While the winding unit 5 winds the ribbon-shaped material N into a spiral and advances the tube T being formed, the cutting unit 33 is in its waiting position (shown in broken lines in Fig. 1 and indicated by 33A therein), in which the said unit 33 is at the left-hand end (as seen in Fig. 1) of its travel. In this position, the follower 83 is under the portion 85a of the cam profile 85. When the cutting unit 33 is in the waiting position, the actuator 77 is kept in a position such that the cutters 63 and 65 are kept separated and therefore not in contact with the tube T, and the follower 83 is removed from the profile 85A.

At the discharge end of the machine (not illustrated) there is a sensor of the optical or similar type, with an adjustable position, which detects the arrival of the initial end of the tube being formed. In Fig. 1, the sensor is schematically indicated by S, but is shown only for information and not in its actual position. The detection of the arrival of the tube causes the sensor to emit a signal which makes the rod 80 emerge from the actuator 77 and starts the actuator

53. The latter moves from zero speed to an operating speed selected and controlled in such a way that, by means of the rack and pinion coupling 49 and 47, the cutting unit 33 is given a speed of advance equal to the speed of advance of the tube being formed, determined in the final analysis by the speed of rotation of the motor 19. A central control unit, indicated schematically by 90 in Fig. 1, controls the actuators 19 and 53, as well as the sensor S, in such a way that the speed of advance of the tube and that of the unit 33 are synchronized in the way described above.

Simultaneously with the starting of the actuator 53, the cylinder and piston actuator 77 is also activated, and causes the extension 59a of the arm 59 to oscillate in a clockwise direction, causing an oscillation of the arms 59 and 61 towards each other with consequent approach of the cutters 63 and 65. This oscillation is opposed by the presence of the follower 83 which initially bears on the portion 85A of the cam profile 85. When the cutting unit 33 starts to advance from left to right (Fig. 1), the follower 83 runs along the profile 85 and moves from the portion 85A to the portion 85B and then to the portion 85C which is in a higher position. During this movement, since the cylinder and piston actuator 77 is under pressure, the follower 83 is kept in contact with the cam profile 85 and the shape of the latter causes oscillation of the arms 59 and 61 with the consequent relative approach of the cutters 63 and 65. The position of the portion 85C of the cam profile 85 is such that, when the follower 83 is on this portion 85C, the cutters 63 and 65 are pressed against the advancing tube. The lengths of the portions 85A, 85B of the cam profile 85 are selected in such a way that the follower 83 arrives at the portion 85C only when the cutting unit 33 has reach a forward traversing speed substantially equal to the speed of advance of the tube T which is to be cut. In this way, the cutters 63 and 65 make a perfect cut of the tube T.

The length of the portion 85C of the cam profile 85 is such that it permits a complete cut of the tube T, and does not have to be changed with a variation of the diameter of the tube produced by the machine. Adaptation to the various diameters of the tube being formed may be carried out by modifying the position of the follower 83 which, for this purpose, has an eccentric axis. The position of the cutters is also adjustable by lengthening or shortening the rod 71.

When the tube has been cut, the cutting unit 33 is decelerated and stopped over a section of the travel during which the follower 83 runs on the portions 85D and 85E of the cam profile 85. In this advance overtravel, the cylinder and piston system 77 causes an oscillation in the opposite direction of the arms 59, 61, with consequent withdrawal of the cutters 63 and 65 from the tube T. When the position of maximum advance (indicated in broken lines by 33B in Fig. 1) has been reached, as detected by a position sensor which is not shown, the cutting unit 33 is accelerated in the opposite direction by a reversal of the rotation of the motor 53, and is returned to its waiting position. In the return travel, the follower 83 does not interact with the cam profile 85, since it is withdrawn by the cylinder and piston 77, and the cutters 63, 65 are kept separate from the tube T which continues to advance at its own production speed.

The circular cutters 63, 65 are provided with a cutting motion obtained by a conversion of the linear motion of the cutting unit 33 by the method described below.

A flexible member 97 (see Fig. 1) is fastened, at two points 93 and 95, to the fixed structure of the machine. In the example illustrated, the fastening point 93 is disposed on the unit 36, while the fastening point 95 is on a column 96. The fastening points 93, 95 of the flexible member 97 are located, respectively, before and after the travel of the

cutting unit 33 with respect to the direction of advance of the tube T being formed. The flexible member 97 is run, as seen in particular in Figs. 3 and 4, around two free-running return wheels 98 and 99 carried by the cutting unit 33. The wheels 98 and 99 have axes substantially parallel to each other and perpendicular to the direction of advance of the tube T, and consequently to the axis of the spindle 1. Between the two wheels 98 and 99, which are staggered with respect to each other as seen in Fig. 4, the flexible member 97 forms a loop which is run around a multiple pulley 101 with an axis parallel to the axis of the spindle 1.

In the example illustrated, the multiple pulley 101 has three grooves 101A, 101B and 101C of progressively increasing diameter, usable as alternatives. In Fig. 3 the flexible member 97 is run in the groove 101B of intermediate diameter. The use of a multiple pulley with grooves of different diameters permits, as will be made clear below, a variation of the speed of rotation of the cutters 63 and 65 with the same speed of advance of the tube T and of the cutting unit 33. The speed of rotation of the cutters is selected in such a way that their peripheral speed is equal to or greater than the peripheral speed of the tube T.

During cutting, the cutters interact with an opposing bush inside the tube T, indicated by 102 in Fig. 1, whose operation is described in the cited Italian Patent No. 1,204,029.

The multiple pulley 101 is fitted on a shaft 103 on which is also keyed a pulley 105 over which is run a belt 107 which takes the motion from the pulley 105 and transmits it to the circular cutters 63 and 65. The belt 107 is run for this purpose not only around the pulley 105 but also around two pulleys 106, 107 integral and coaxial with the cutters 63, 65 and around free-running guide pulleys 108 and 109 carried by the unit 33.

With the disposition illustrated above, when the cutting unit 33 moves as shown by the arrow f33

under the action of the motor 53, the flexible member 97 (a plain open belt of circular section in the example illustrated), being fastened at two fixed points to the structure of the machine, causes a rotation of the multiple pulley 101 and consequently a rotation of the pulley 105 and therefore of the circular cutters 63 and 65. Clearly, the direction of rotation of the circular cutters depends on the direction of advance of the cutting unit 33 and the said cutters reverse their rotation when the cutting unit 33, having reached the final position of its travel, moves back again. The rotation of the circular cutters during the return travel of the cutting unit 33 has no effect, since the said cutters have previously been withdrawn from the tube T by the method described above.

It is to be understood that the drawing shows only an example provided solely as a practical demonstration of the invention, and that this invention may be varied in its forms and dispositions without departure from the scope of the guiding concept of the invention. The presence of any reference numbers in the enclosed claims has the purpose of facilitating the reading of the claims with reference to the description and to the drawing, and does not limit the scope of protection represented by the claims.

CLAIMS

1. Machine for producing tubes by winding into a spiral a ribbon-shaped material (N) on a spindle (1), comprising a winding unit (5) which continuously winds into a spiral two or more overlapping or staggered strips of ribbon-shaped material (N) on the said spindle (1) and causes the tube (T) formed from the said material to advance continuously, and a cutting unit (33) fitted with tube (T)-cutting means (63, 65) and provided with a reciprocating traversing motion along the direction of advance of the tube, to cut the said tube into sections of predetermined length during the advance of the tube, characterized in that the said winding unit (5) is driven by a first actuator (19), the reciprocating motion of the cutting unit (33) is provided by a second actuator (53), and the said actuators are electronically controlled (90) in such a way that the speed of advance of the cutting unit (33) during the cutting is substantially equal to the speed of advance of the tube produced by the said winding unit (5).

2. Machine according to Claim 1, in which the said cutting unit moves, for each cutting operation, in the direction of advance of the tube, through a first section of travel at a speed increasing from zero to the speed of advance of the tube, a second section of travel at a speed substantially equal to the speed of advance of the tube, and a third section of travel at a speed decreasing from the speed of advance of the tube to zero, before moving through a return travel in the opposite direction, the cut taking place during the said second section of travel.

3. Machine according to Claim 1 or 2, characterized in that the said actuators (19, 53) are electric motors.

4. Machine according to one or more of the preceding claims, characterized in that the said second actuator (53) is mounted so that it is fixed on the

structure of the machine, means (47, 49) being provided to link the said second actuator kinematically with the said cutting unit (33).

5. Machine according to Claim 4, characterized in that it comprises a rack and pinion system (47, 49) to link kinematically the said second actuator and the said cutting unit.

Fig. 1

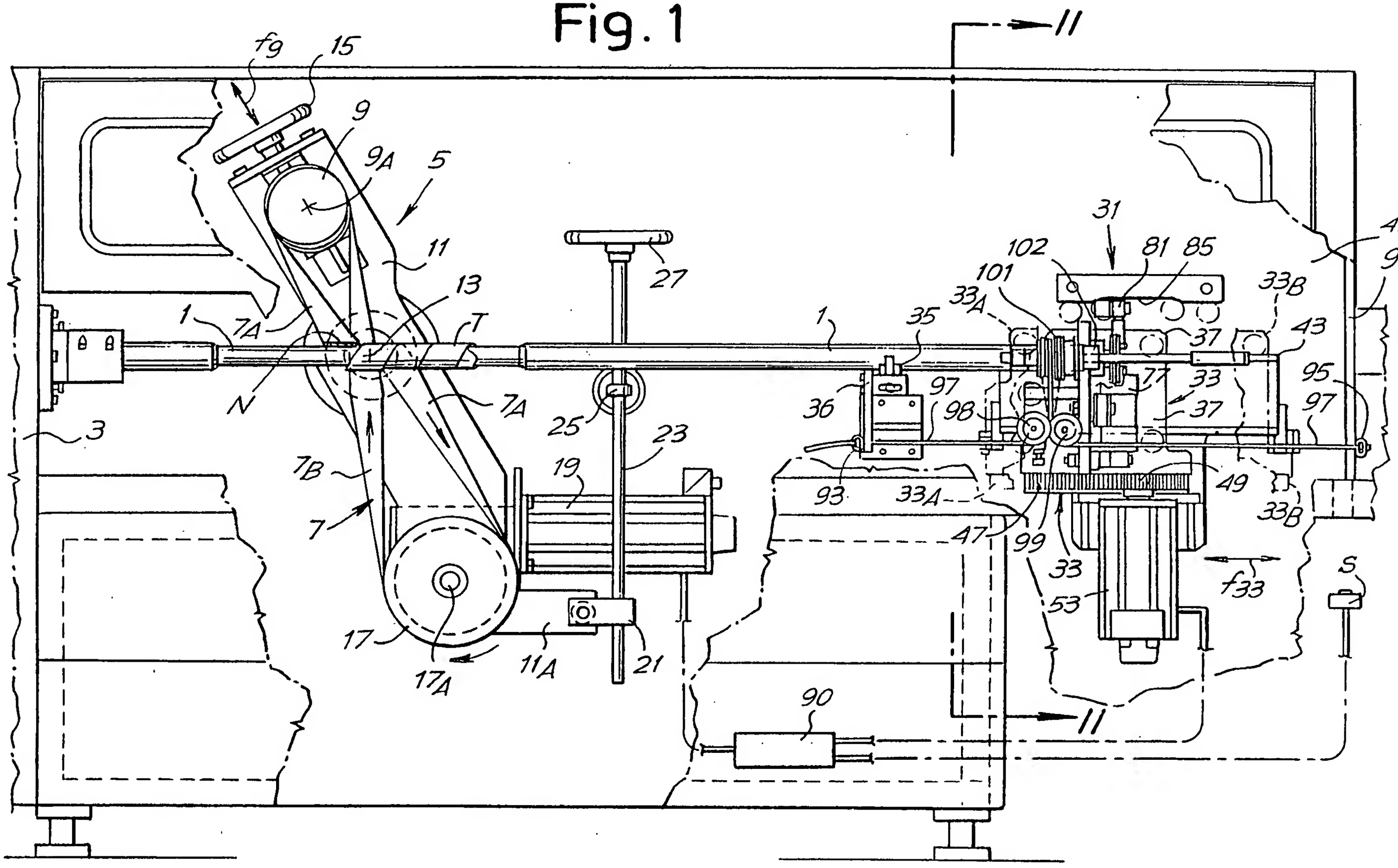
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Fig. 2

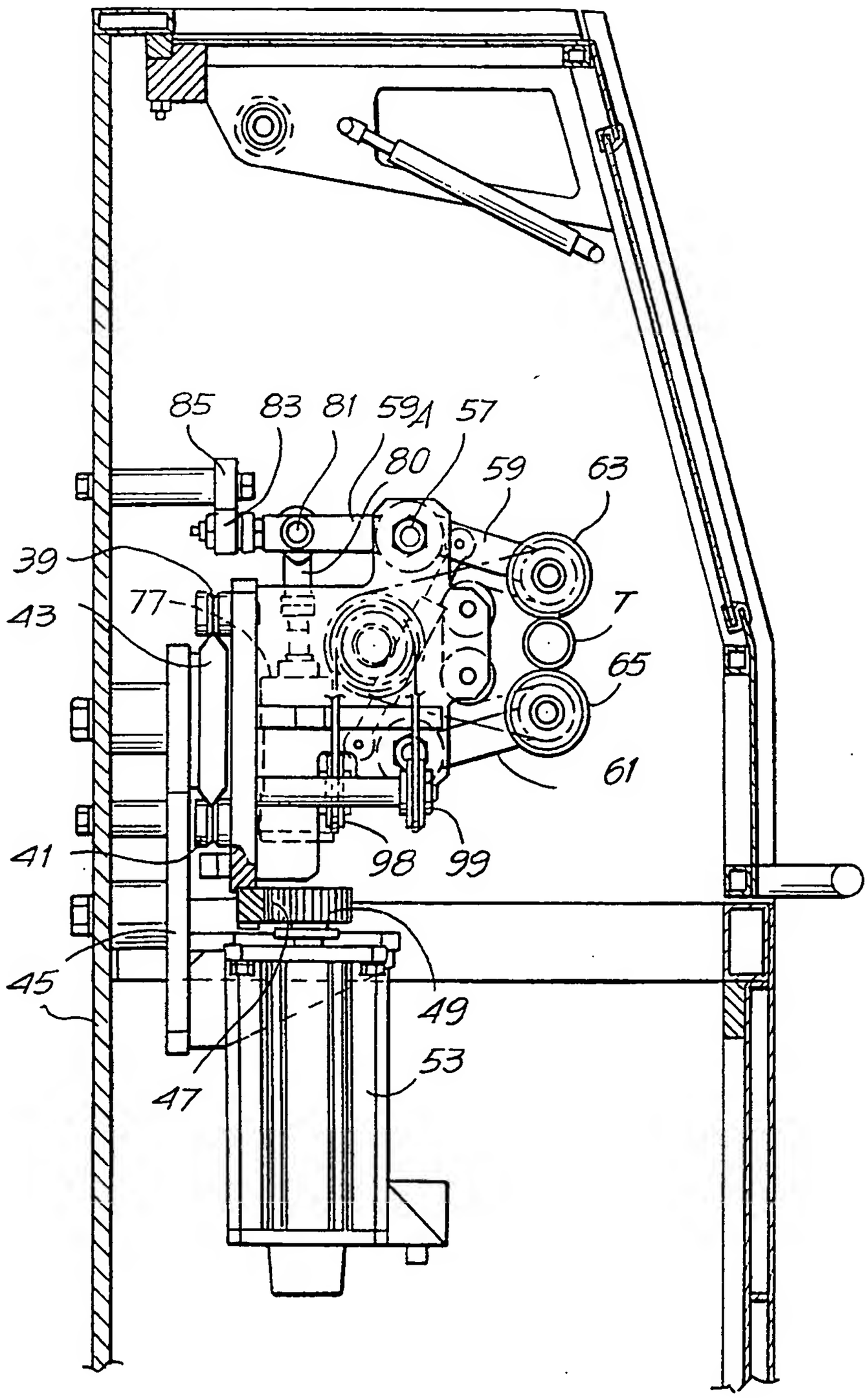

Fig. 3

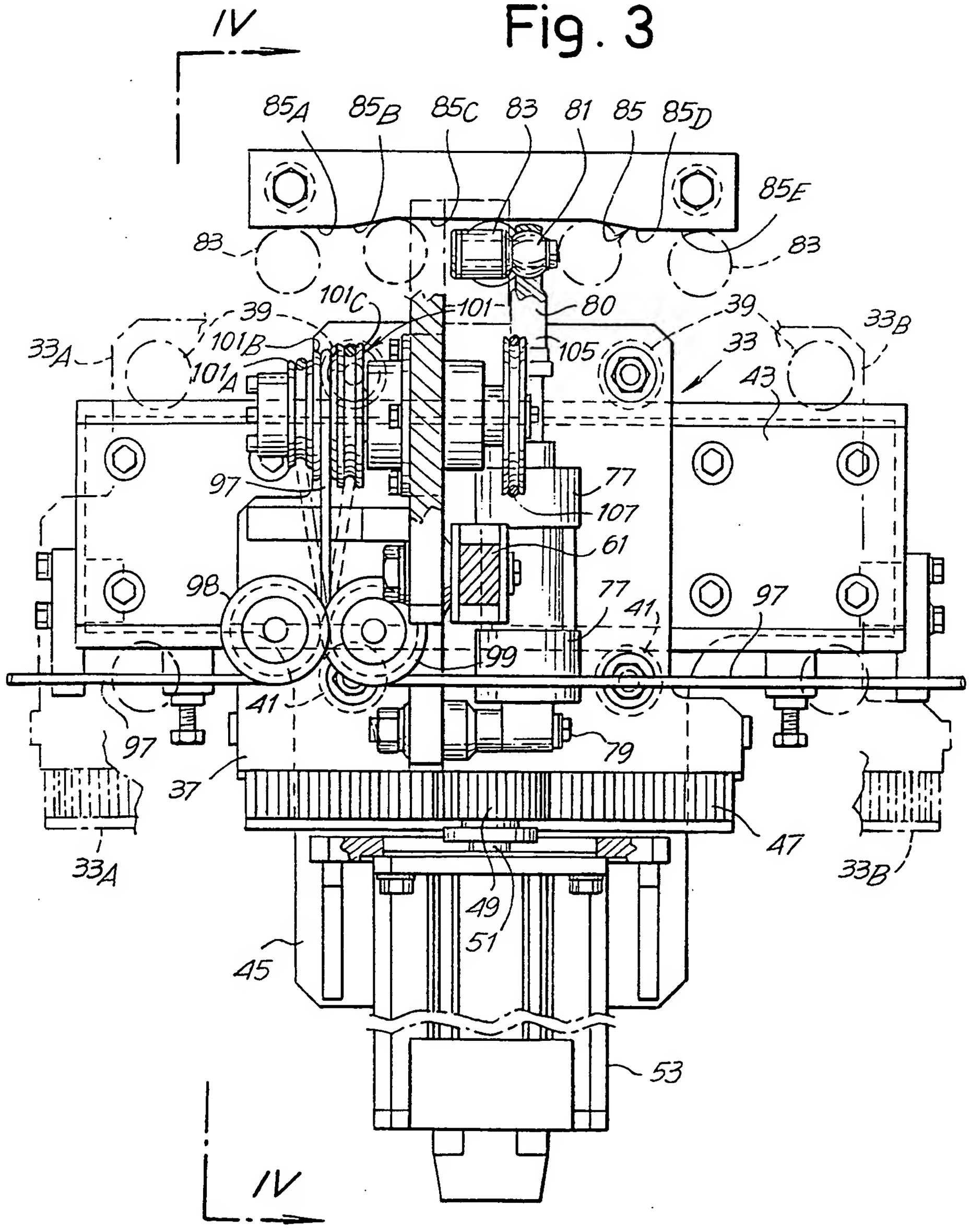
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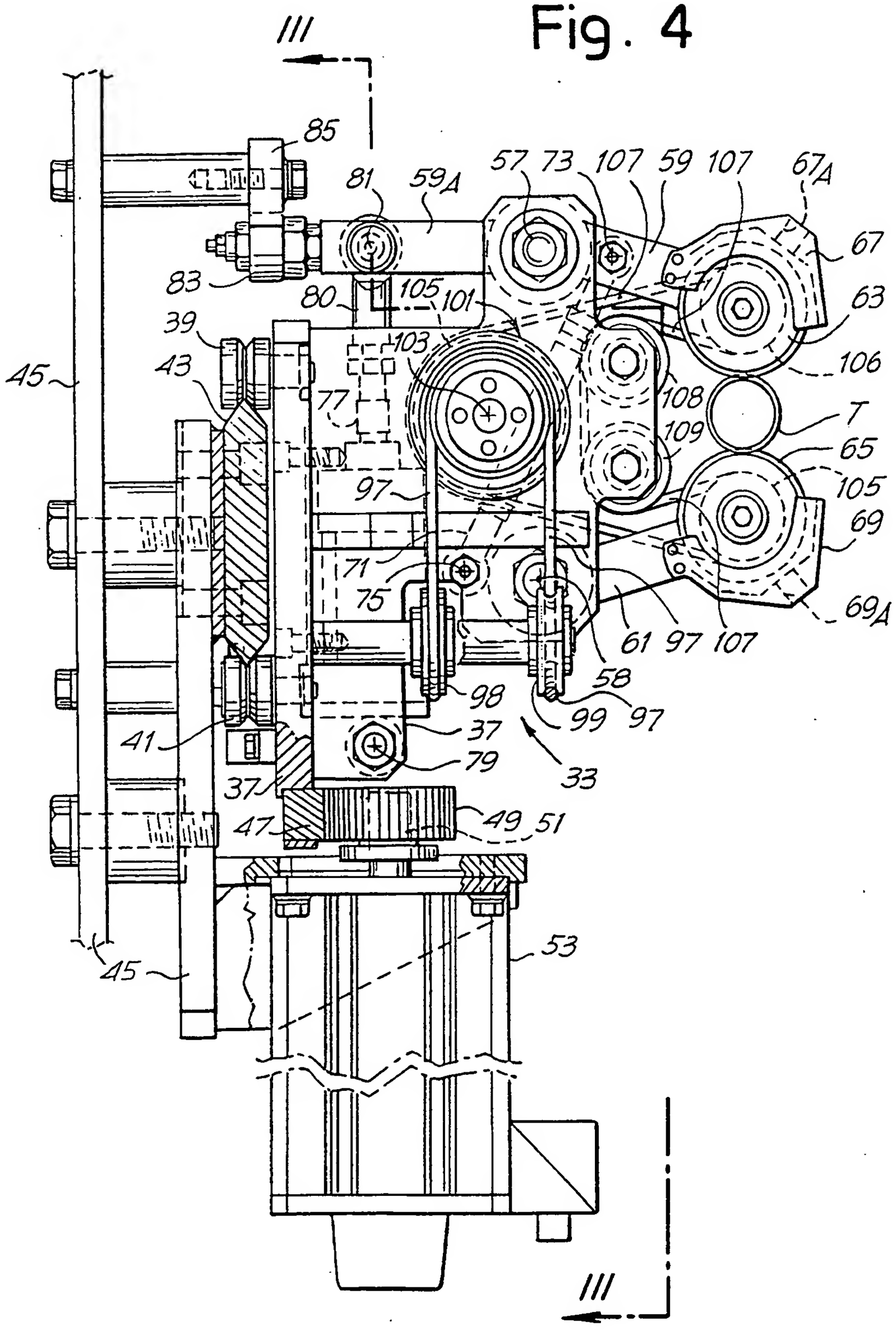
Fig. 4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III

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B26D1/60 B26D5/20 B31C11/00 B31C3/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B31C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US,A,4 370 140 (FEGLEY ET AL.) 25 January 1983 see column 2, line 23 - column 3, line 65 see column 7, line 13 - line 64 ---	1-4
X	US,A,3 942 418 (SMITH) 9 March 1976 see column 2, line 4 - column 3, line 62 see figures ---	1
A	DE,A,35 31 699 (CHRISTIAN MAJER GMBH & CO KG MASCHINENFABRIK) 12 March 1987 see column 2, line 56 - column 3, line 31 see figure 1 ---	1
A	EP,A,0 479 060 (MASCHINENFABRIK HENNECKE GMBH) 8 April 1992 see column 3, line 41 - column 4, line 31 see figure 1 ---	1-3
	-/--	

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
23 January 1995	- 7. 02 95

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	AU,A,4 281 372 (OLIMS ENGINEERING PTY LIMITED) 29 November 1973 see page 11, line 3 - line 10	1,2
A	EP,A,0 315 601 (LAPICCIRELLA) 10 May 1989 see figures 2,3	5

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